

# Candidate landing sites in Valles Marineris: Ancient and Modern habitability

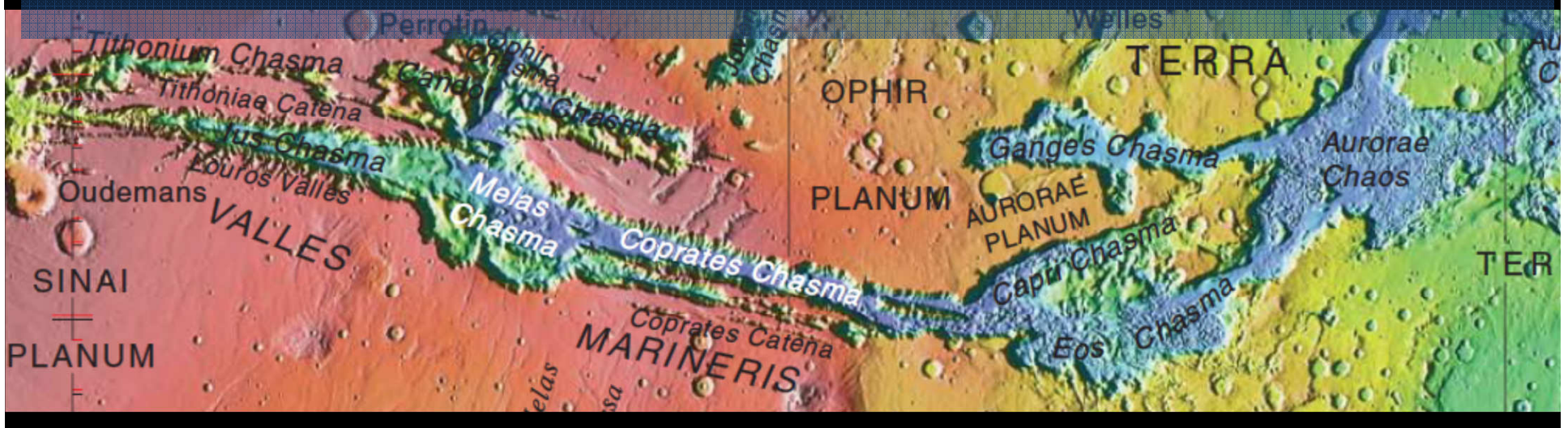
H. Miyamoto (U Tokyo), G. Komatsu (IRSPS) ,  
A. McEwen, and M. Chojnacki (U Arizona),  
+T. Usui (TiTech) and A. Yamagishi (TUPLS)

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# Summary

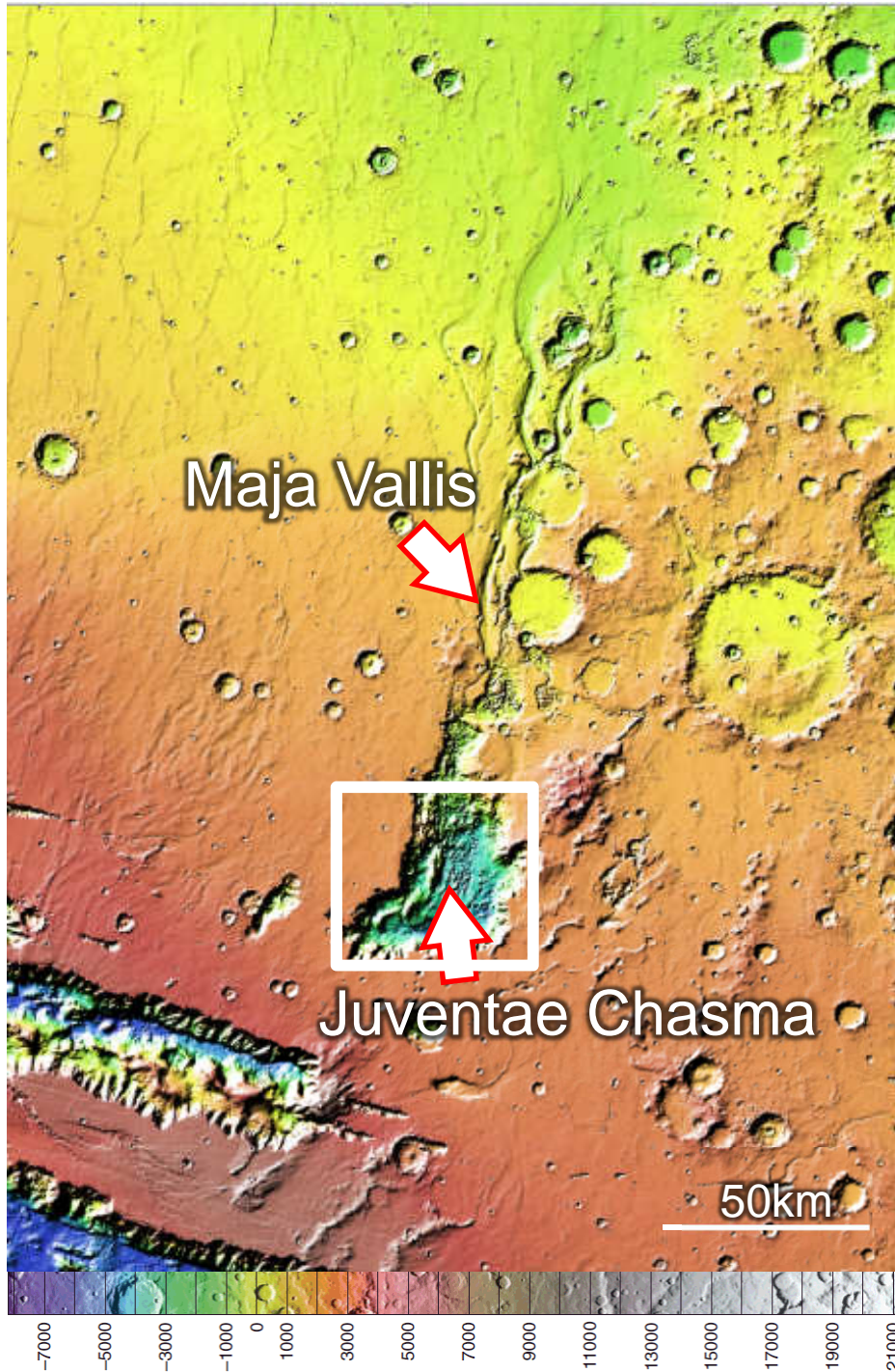
- Mars 2020 objective is to study ancient habitability
- Valles Marineris provides the best exposures of the ancient geologic history of Mars
  - Interior Layered Deposits (ILDs) show various sulfates deposits, suggesting existence of abundant past water
  - The canyons may also have the best sites to investigate present-day habitability: Recurring Slope Lineae (RSL)
  - Due to planetary protection rules, we expect to observe RSL remotely on nearby slopes, but not directly visit with rover
- Difficult to find acceptable landing sites due to steep slopes and winds
  - We think there are possibilities in Melas Chasma, and maybe elsewhere (Capri Chasma and Juventae Chasma)





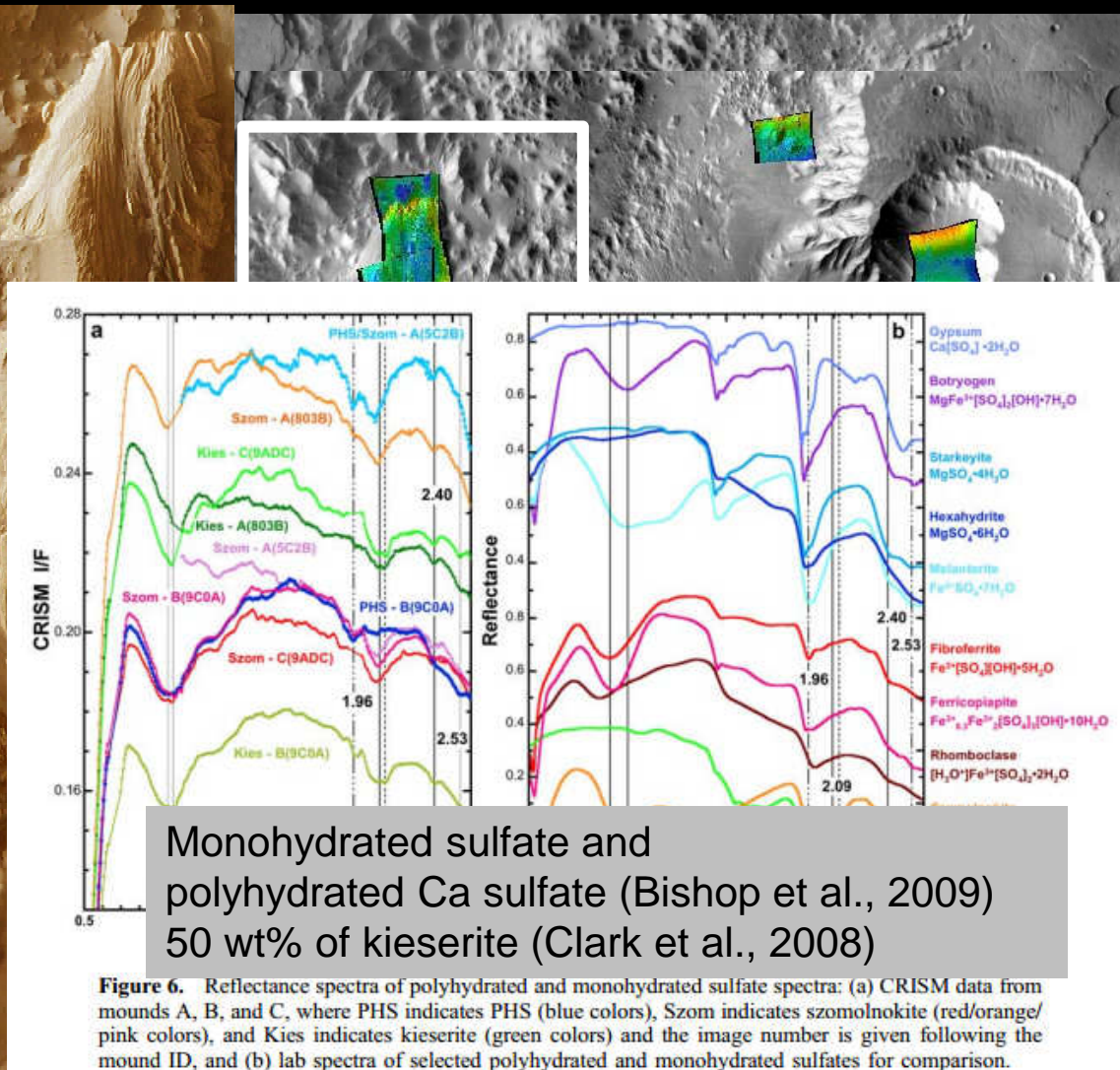
# Juventae Chasma

- In the context of the Valles Marineris system
- Connected to Maja Vallis outflow channel
- Low point: -4.5km  
(>6km below surrounding plateau)



# ILDs; Results of ancient aqueous history

Absence of small craters and high thermal inertia indicate that the ILDs are composed of sedimentary rock (Catling et al., 2006). Gypsum, Juventae Chasma LLO material, forms only at low temperatures ( $<60^{\circ}\text{C}$ ) and thus excludes a volcanic origin. (Catling et al., 2006)





**“Confirmed” RSL at the top of the knob**

500 m

MY 31

L<sub>s</sub>

0

90

180

270

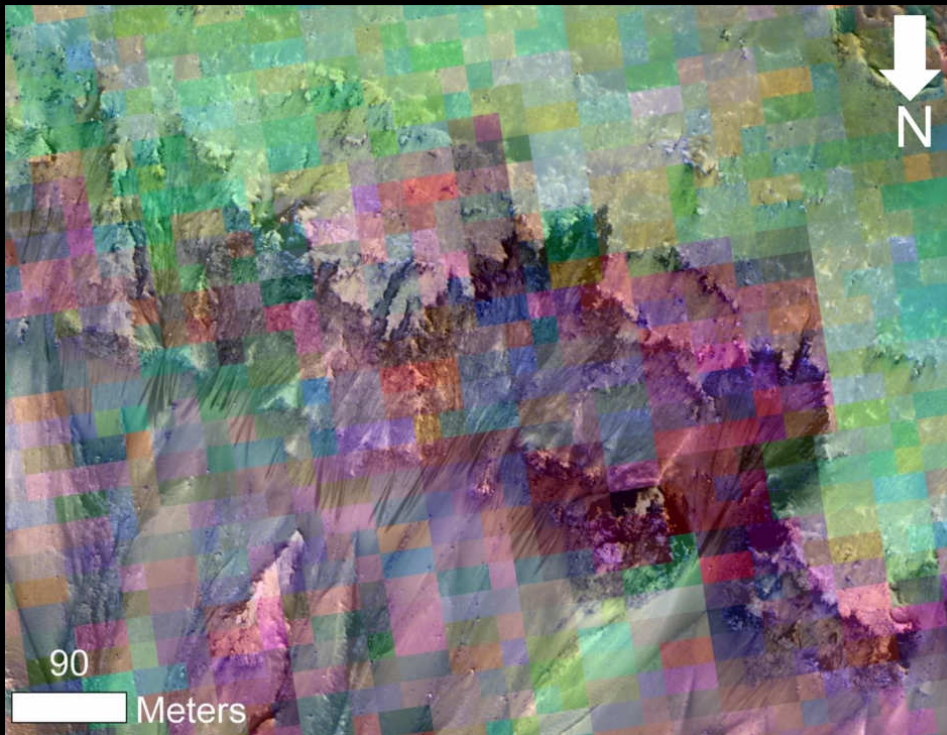
360

ESP\_030373\_1755

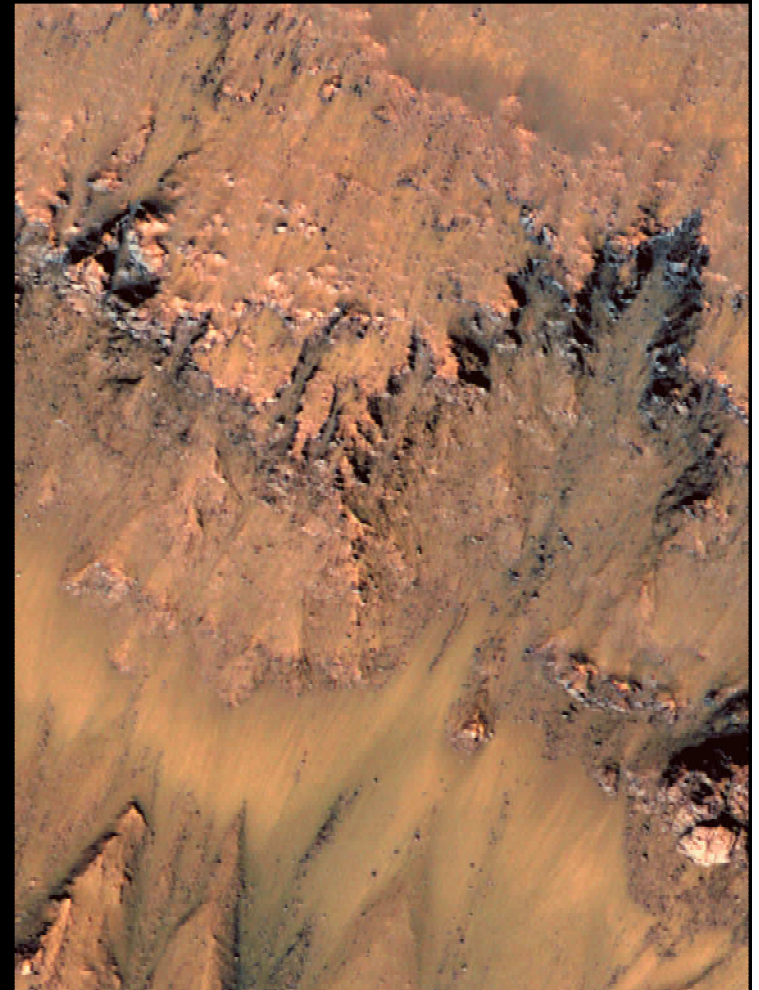


# RSL: Most easily explained by aqueous origin(s)

- Incremental growths during warm seasons. Fading in cold seasons
- Appear only on warm slopes when surface temperature is  $>250\text{K}$
- Liquid brine near the surface might explain this activity
- But the source of water and mechanism behind its motion are not understood (e.g., McEwen et al., 2011; 2013)

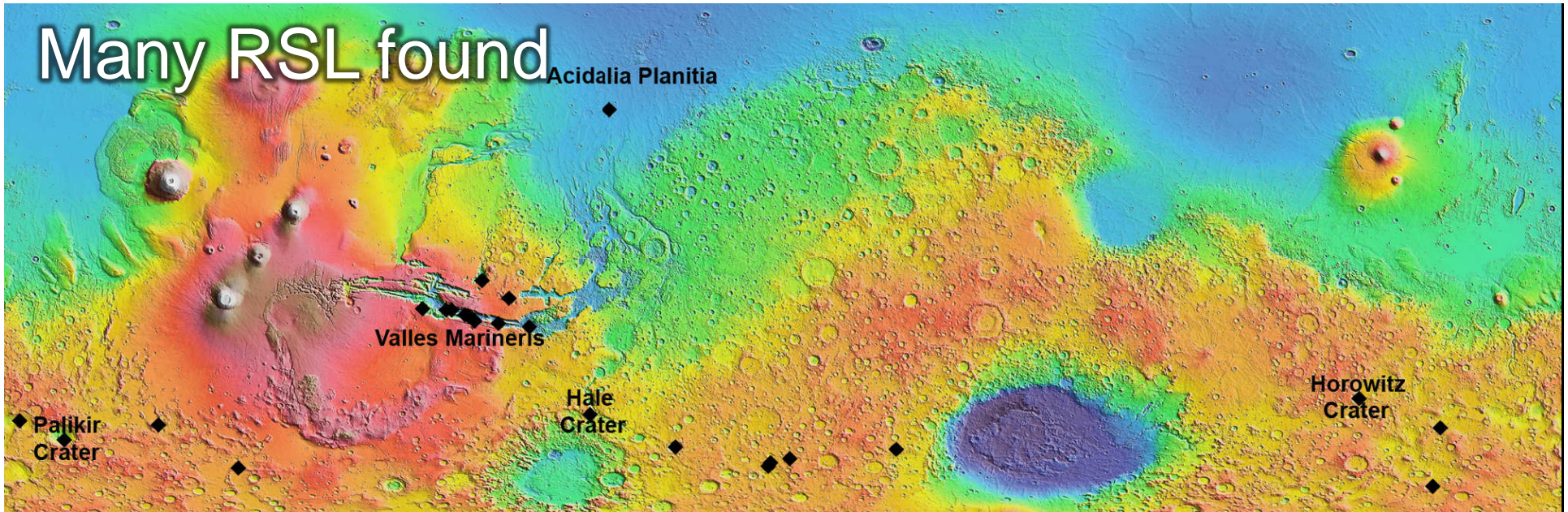


Strength of absorptions at 920 and 530 nm (ferric iron) varies seasonally -- weaker when the RSL are inactive and stronger when the RSL are active (Ojha et al., 2014)





# Many RSL found



Most in southern hemisphere (summer in southern hemisphere is warmer than northern hemisphere)

## Many to be explored:

What time of day are RSL active?

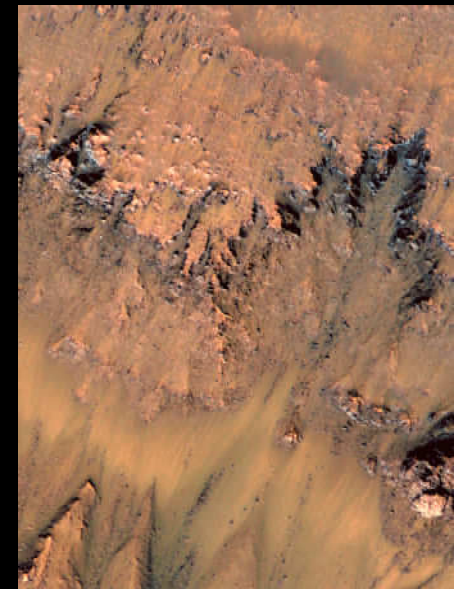
What is the salt composition and concentration?

Where does the water come from?

No dry phenomena?

Is the water activity high enough for life?

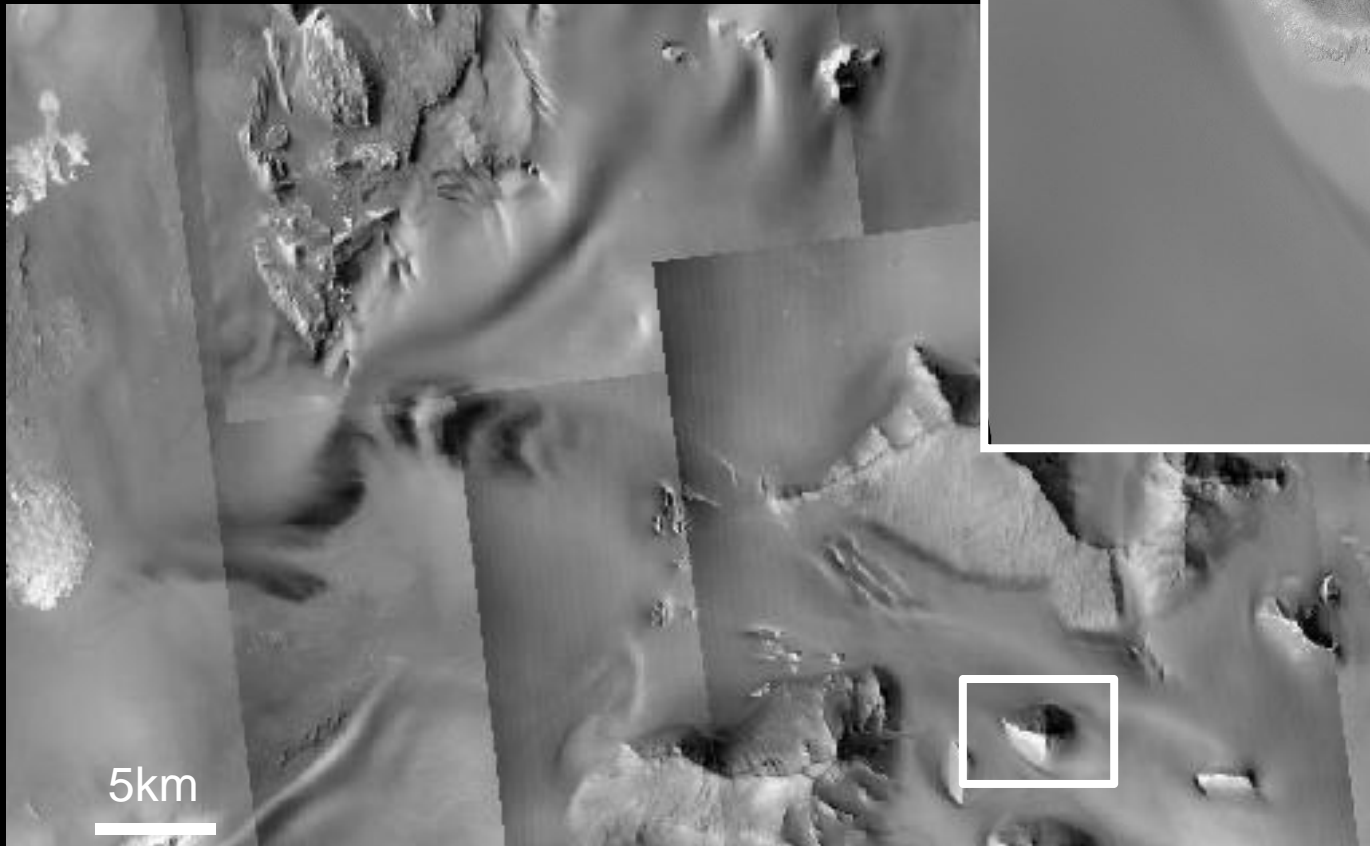
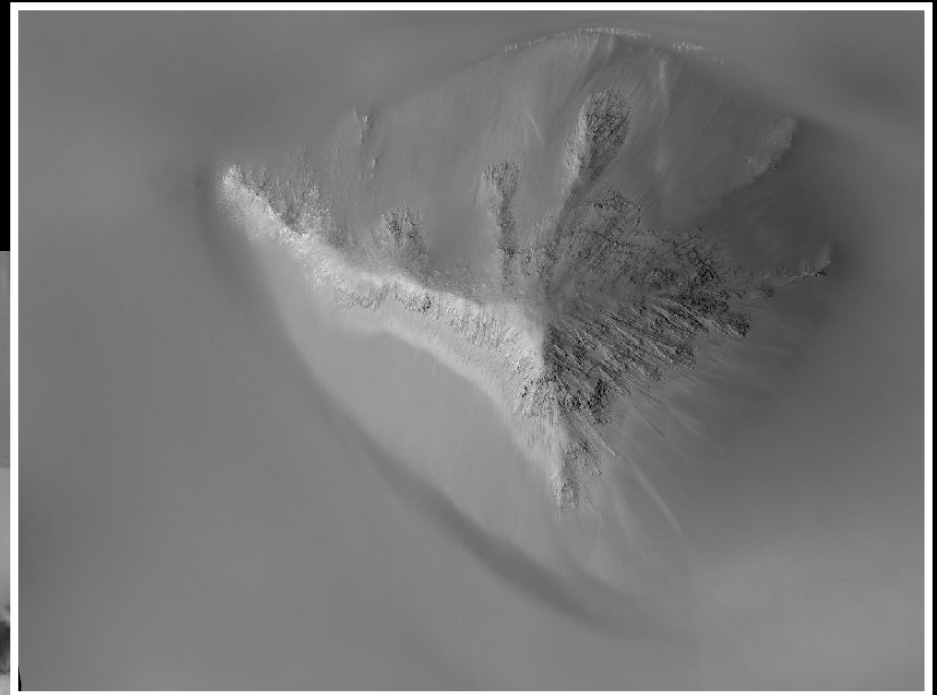
Do RSL sample water from subsurface habitats?



# Special Region?

Lengths of RSL and associated slope phenomena are expectable

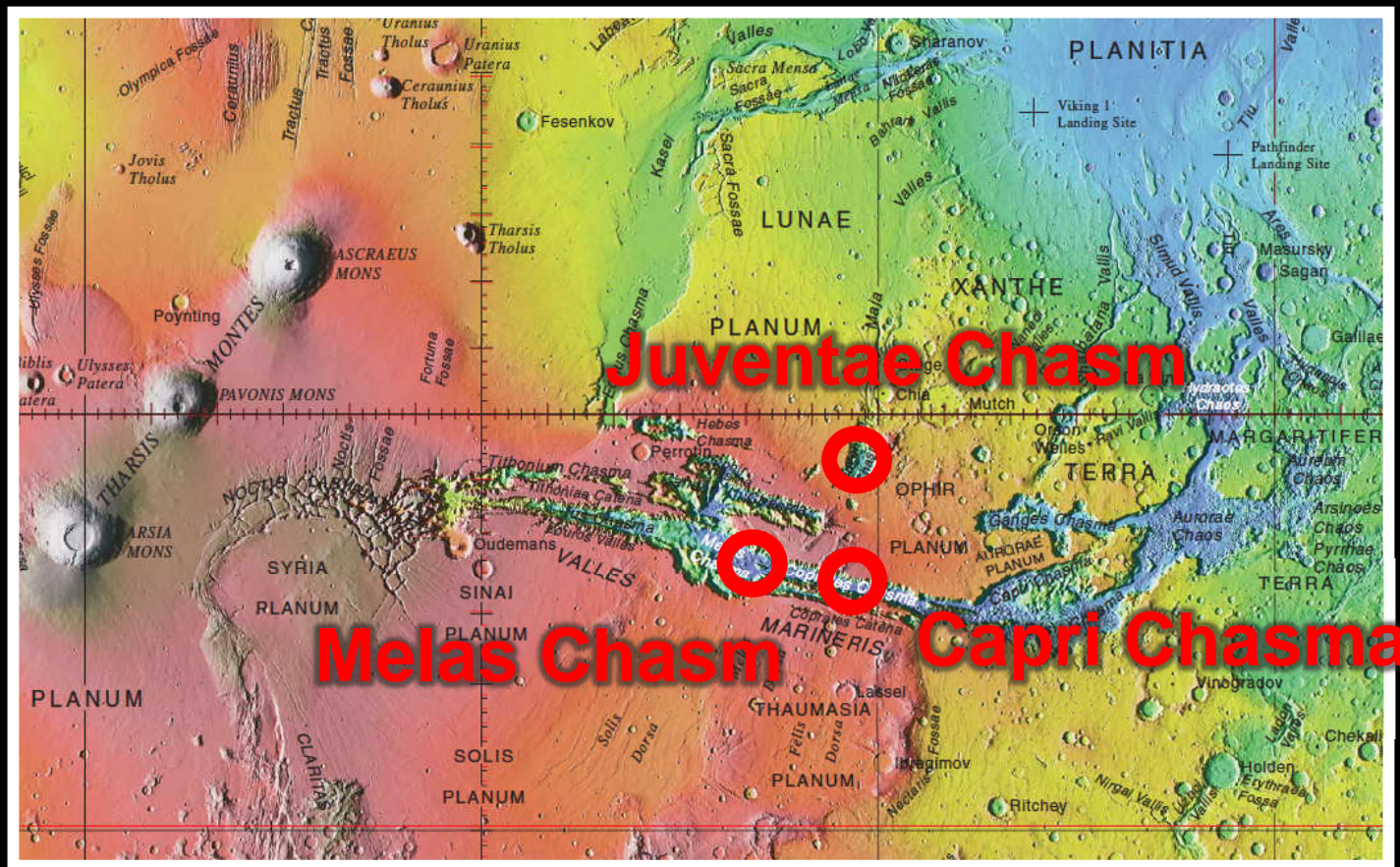
Observing RSL remotely but not visiting with rover may be possible without violating planetary protection rules





Valles Marineris is a unique place holding evidence of ancient and current aqueous activities

We propose **Juventae, Melas, and Capri Chasmata** as possible landing sites





## Site Name

Juventae

Center Coordinates

61.58W 4.39S

Elevation

-3100

Prime Science and distance

ILD 17 km

Volcanic rock 19 km

RSL 34 km

Sulfate mounds

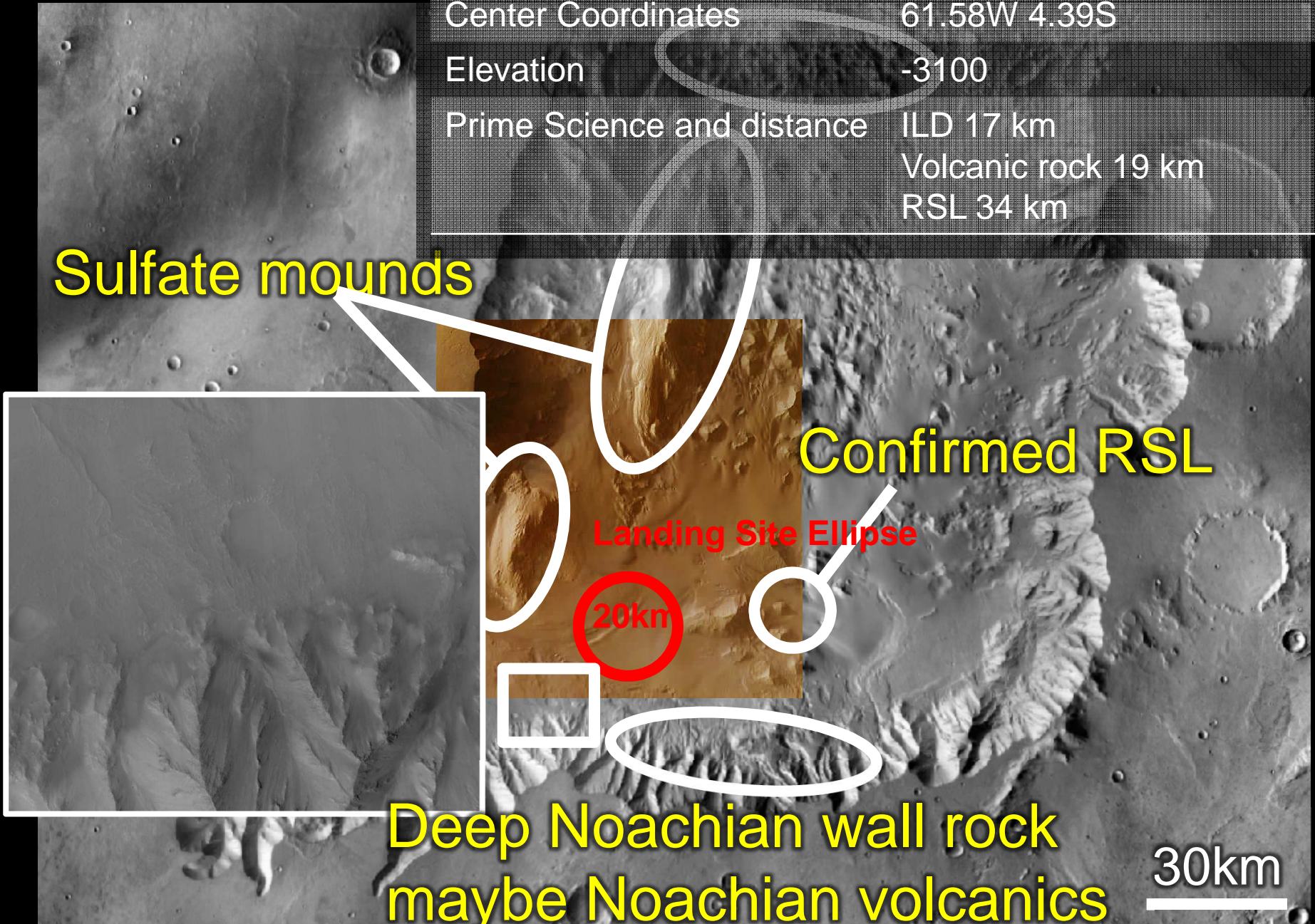
Confirmed RSL

Landing Site Ellipse

20km

Deep Noachian wall rock  
maybe Noachian volcanics

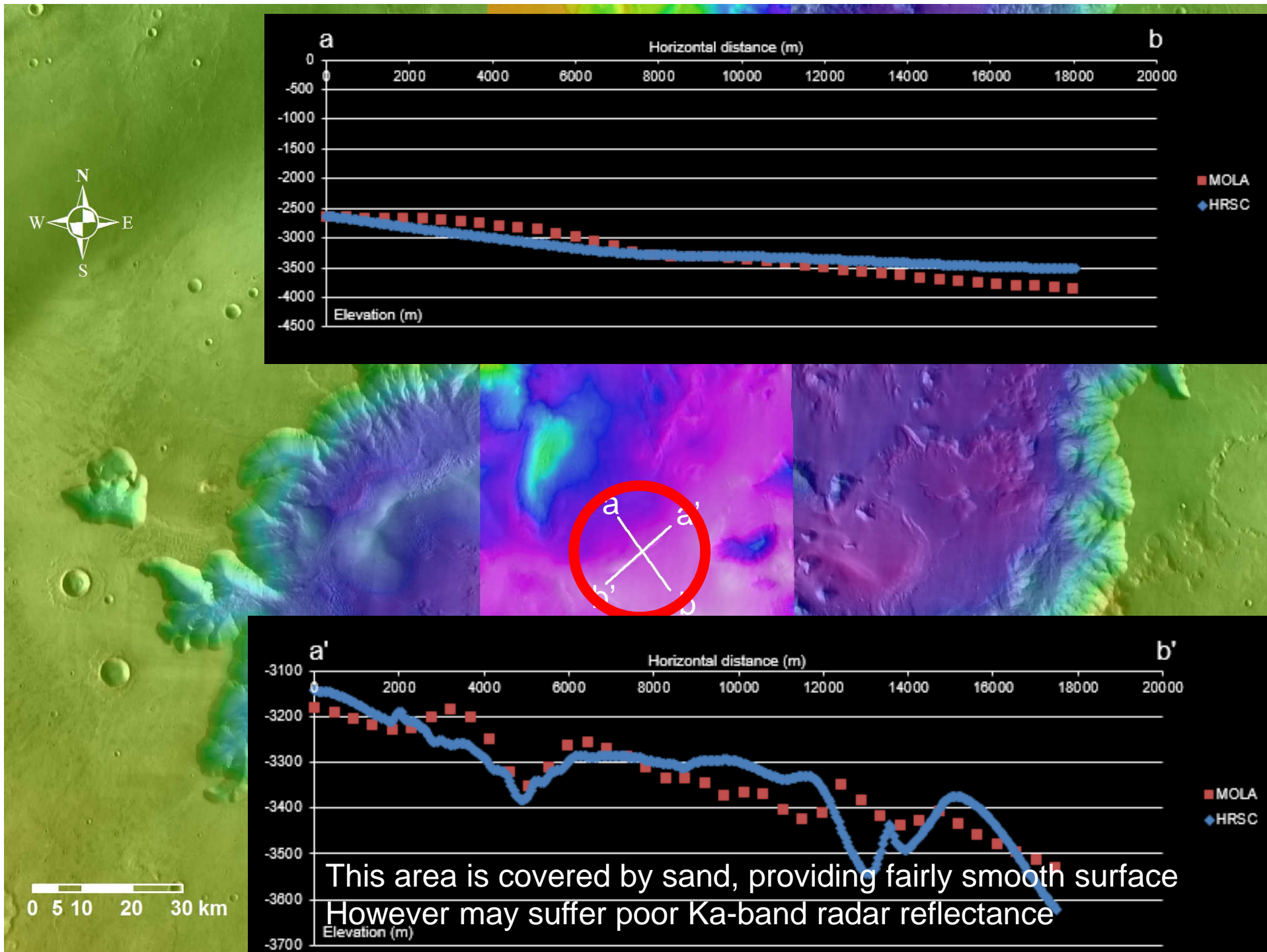
30km







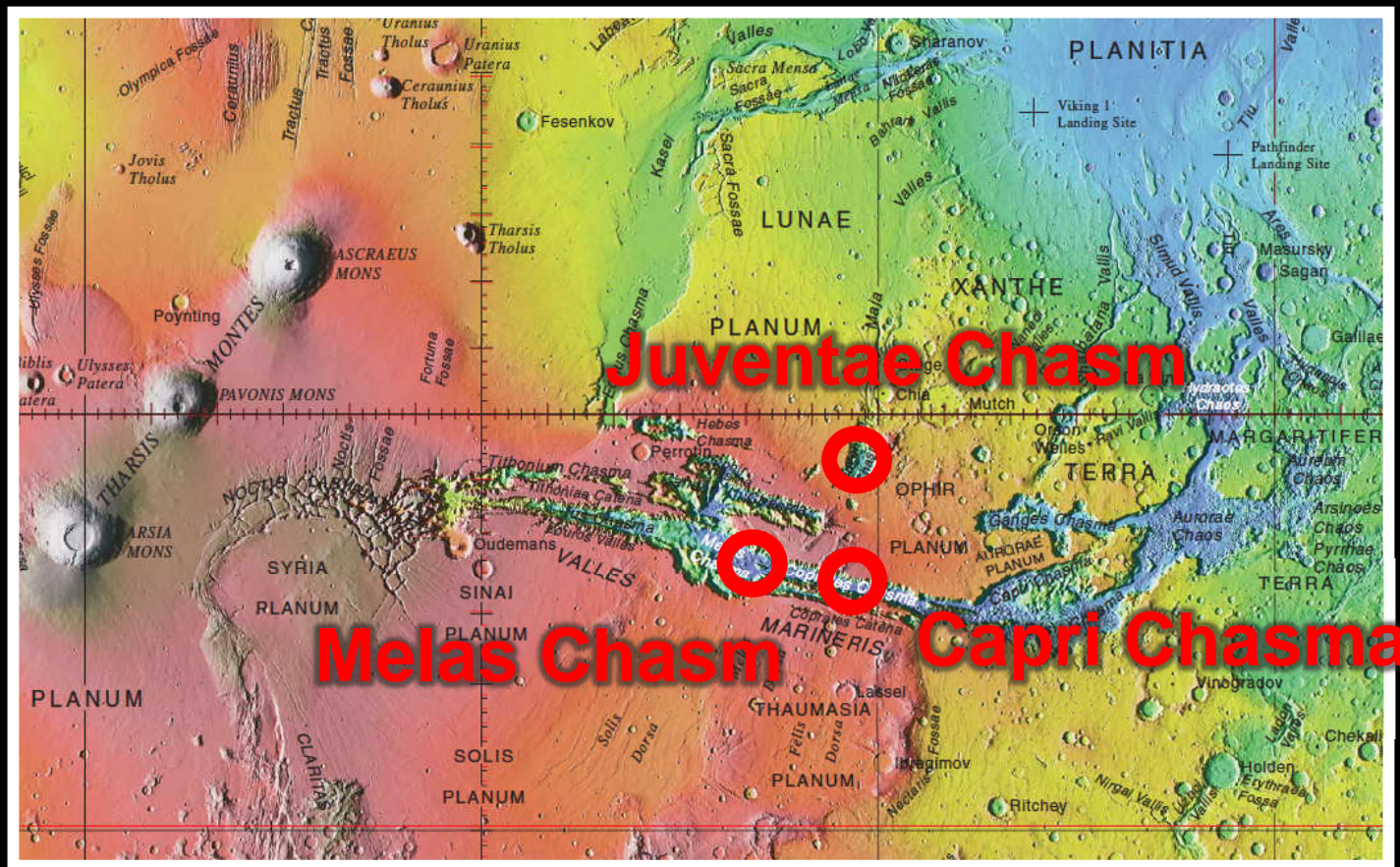






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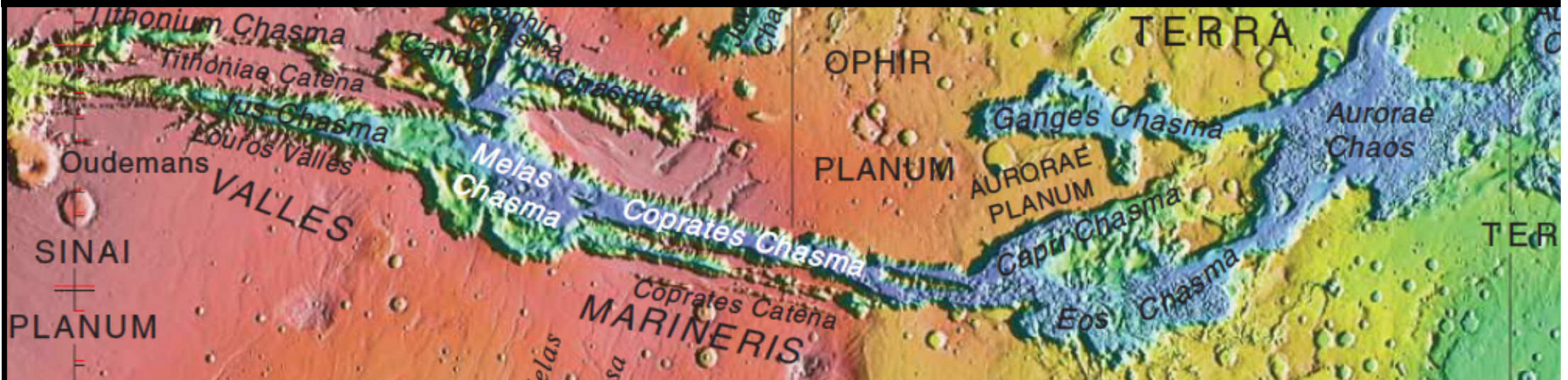


# Melas Chasma:

## Widest and deepest part of the Valles Marineris


Outflow channels are 0.03 degree slope upward to the northern plains; would have a lake with a depth of one kilometer before flow out to the northern plains (e.g., Golombek 1989)

Hydrated sulfates and various phyllosilicates detected among canyon units, suggesting existence of abundant past water (e.g., Gendrin et al., 2005, Murchie et al., 2009, Roach et al., 2010; Weitz et al., 2012, 2014)



Deepest part near the equator; may be useful for future manned mission/base

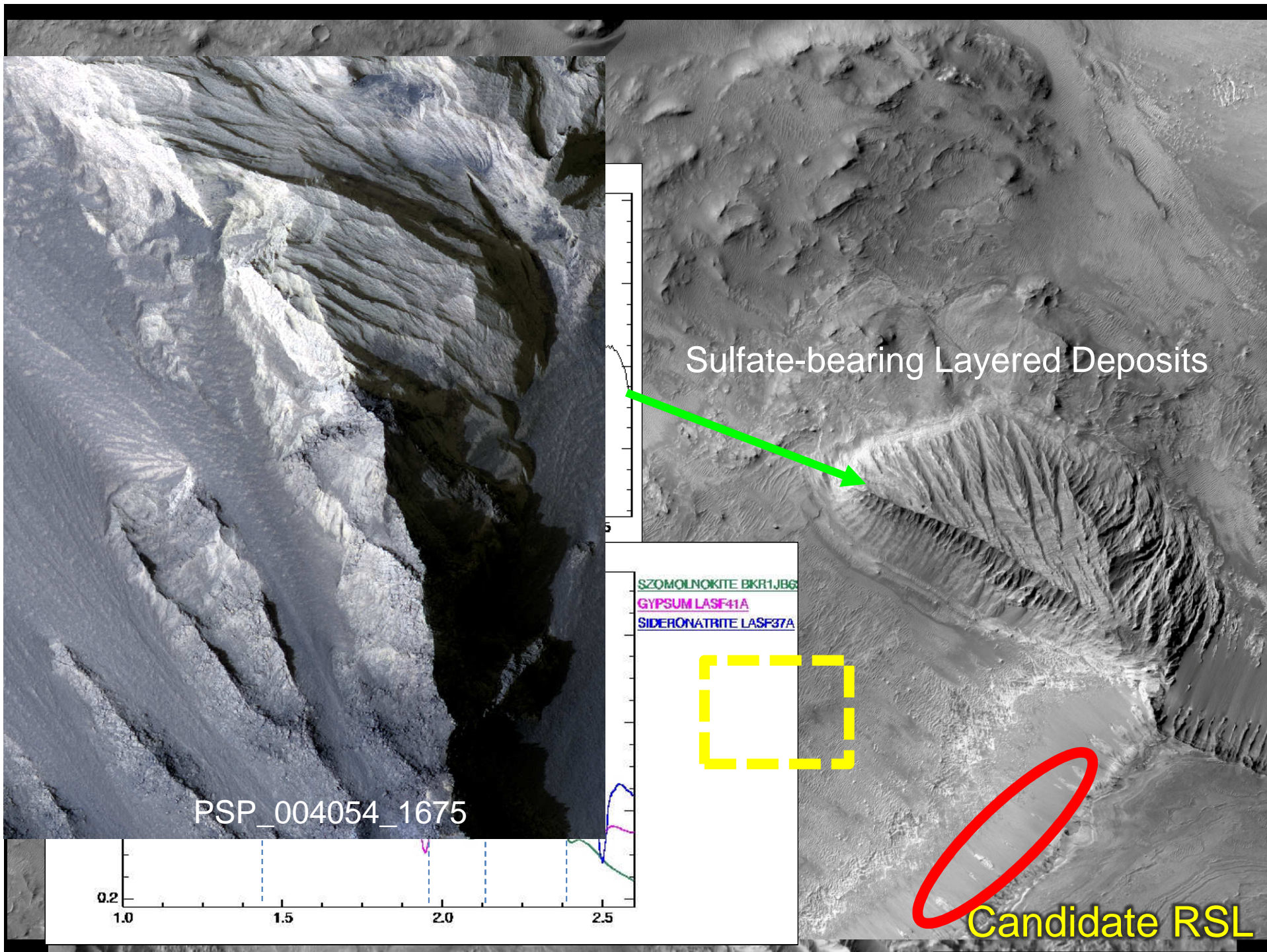




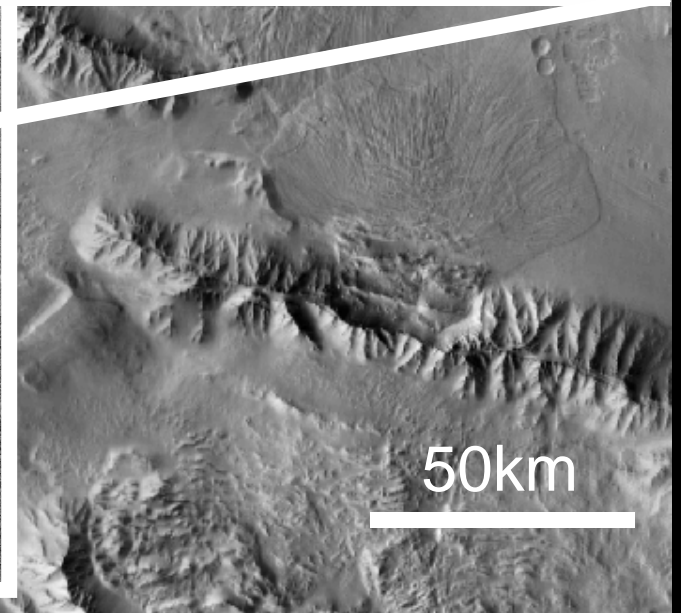
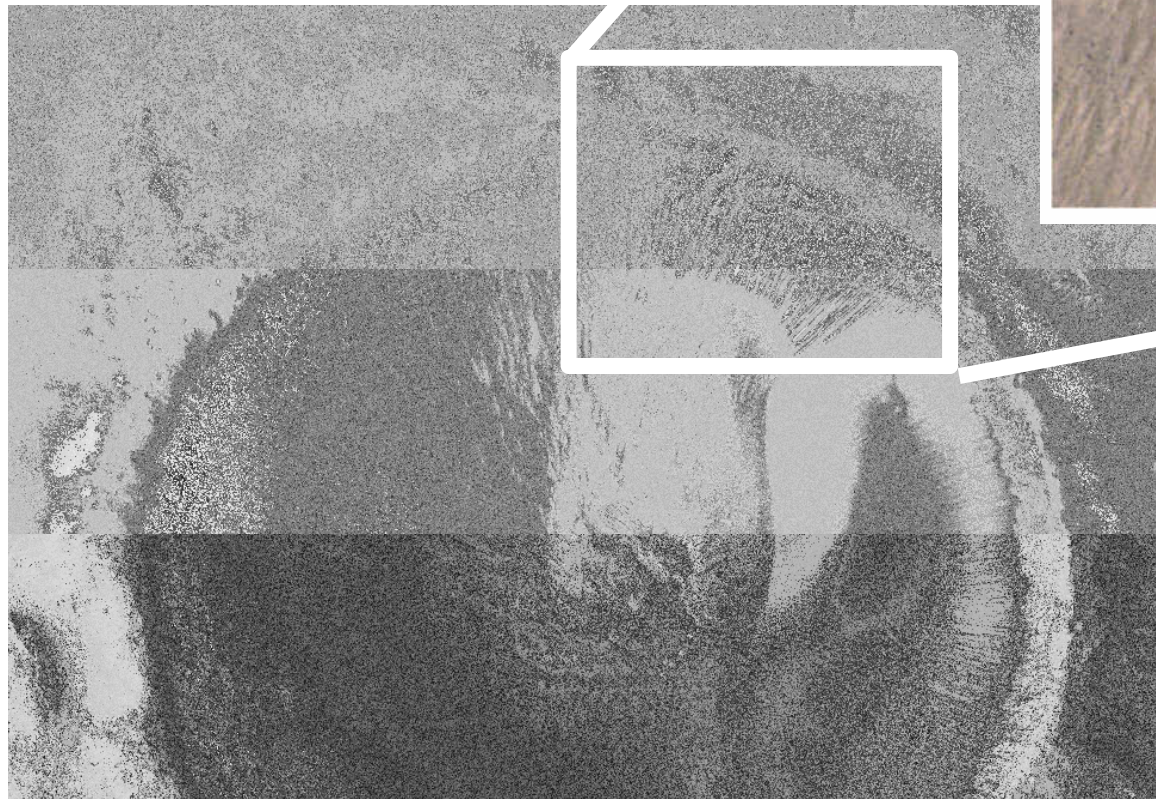
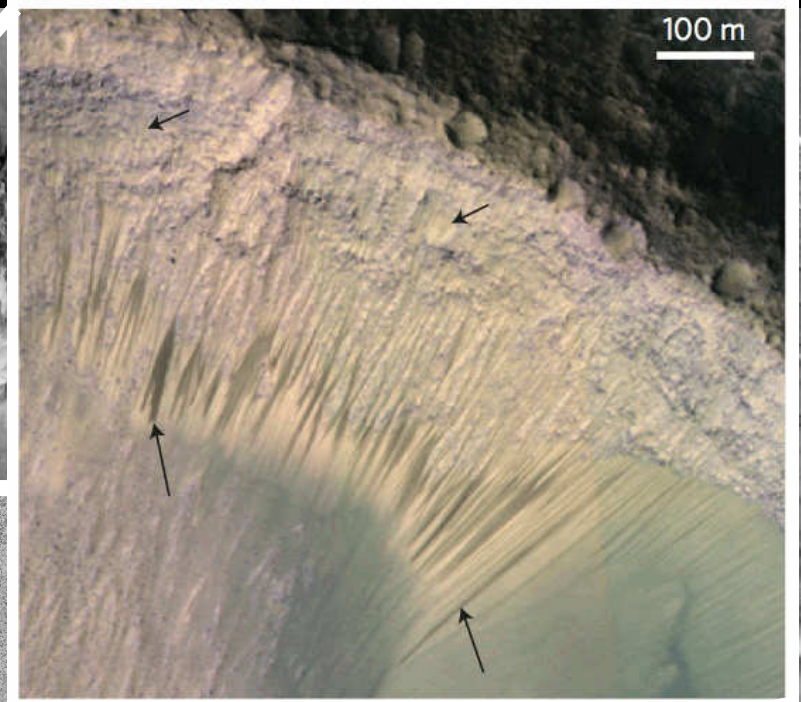
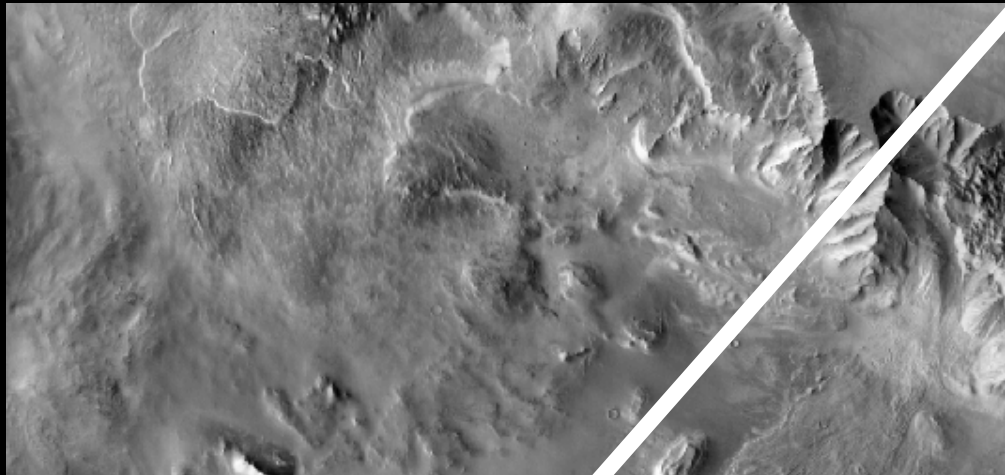
Red: kieserite type  
Green: polyhydrated sulfate  
(Gendrin et al., 2005; OMEGA)

50km









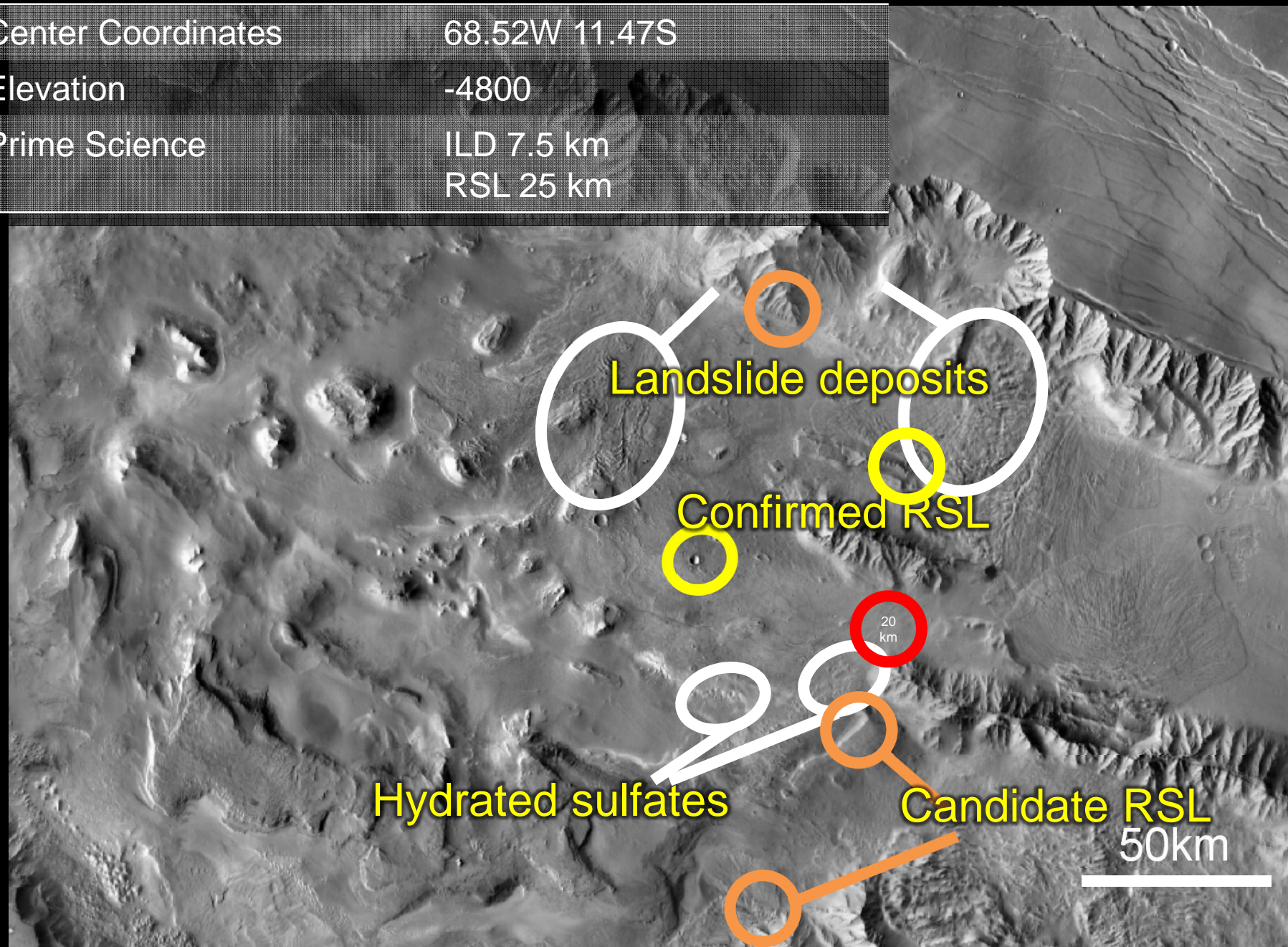


<b>Site Name</b>	<b>Melas Chasma</b>
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Center Coordinates	68.52W 11.47S
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Elevation	-4800
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Prime Science	ILD 7.5 km RSL 25 km
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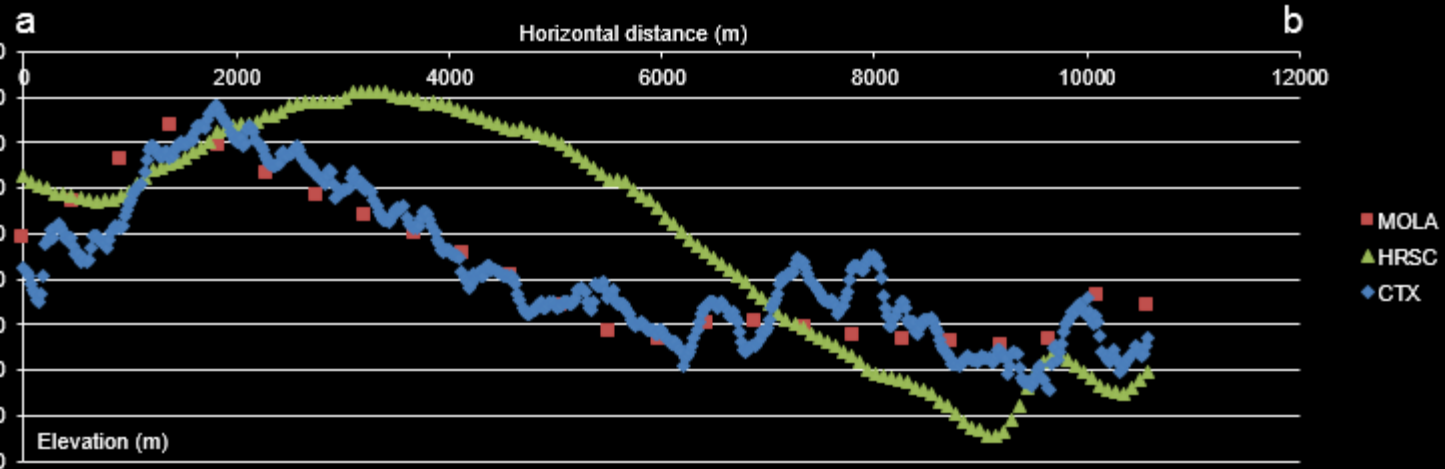


# Melas Cha

MOLA  
Topograph  
(463 m/pix)

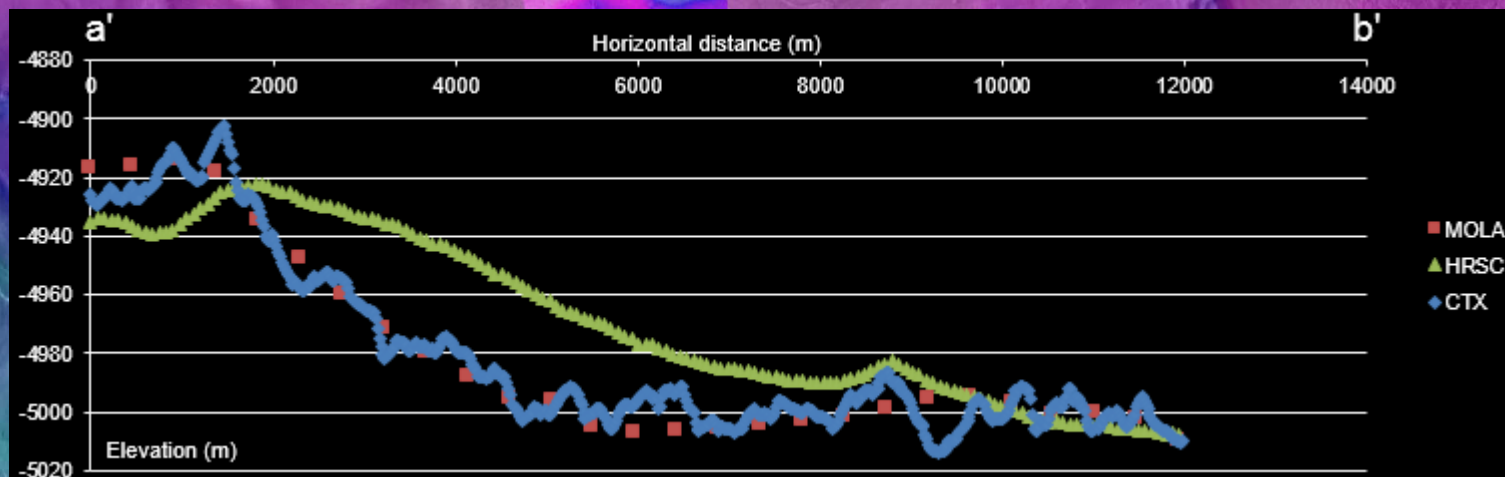


0 5 10 20 30 km



CTX DEM  
(20 m/pix)

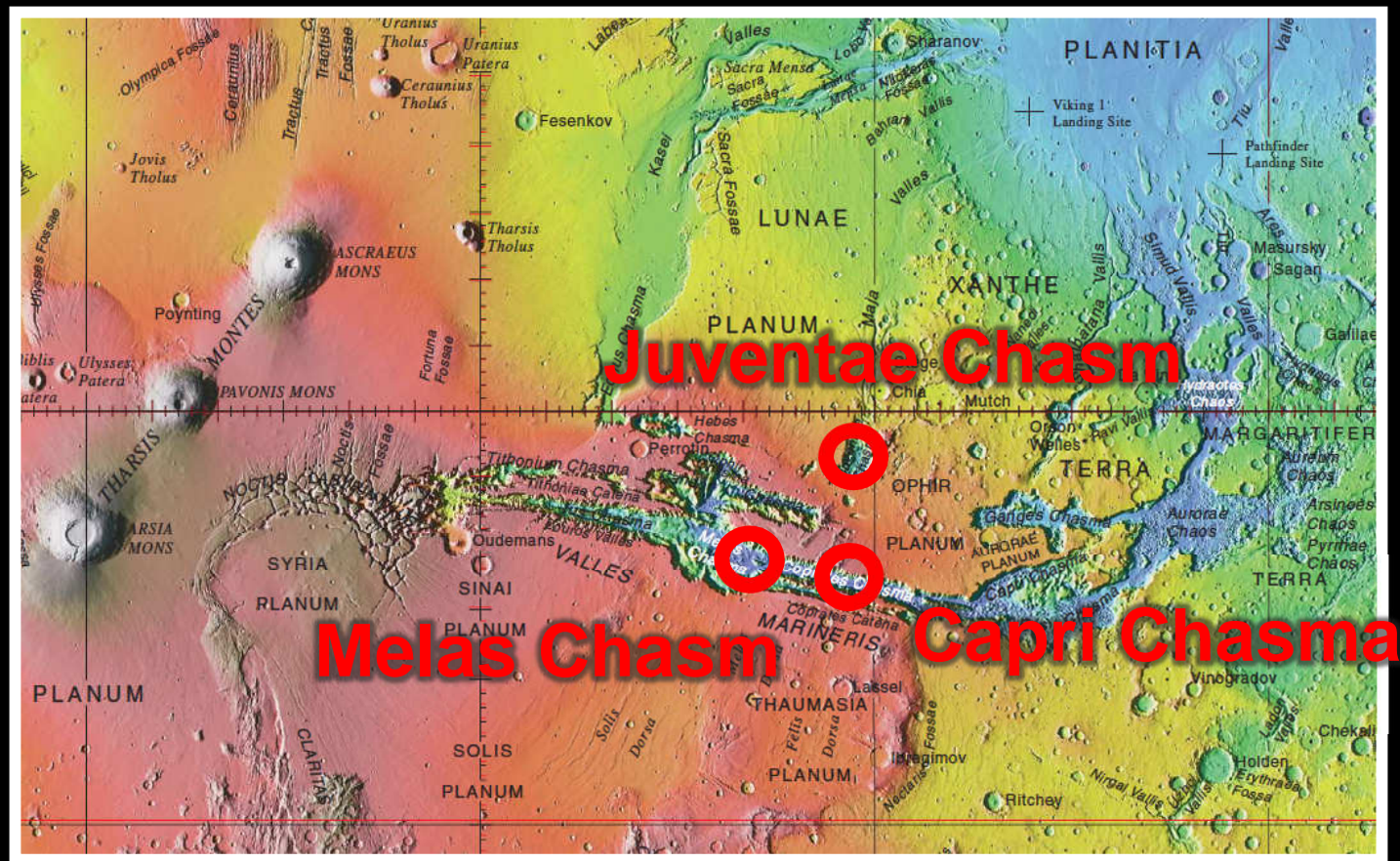
a a'  
b b'





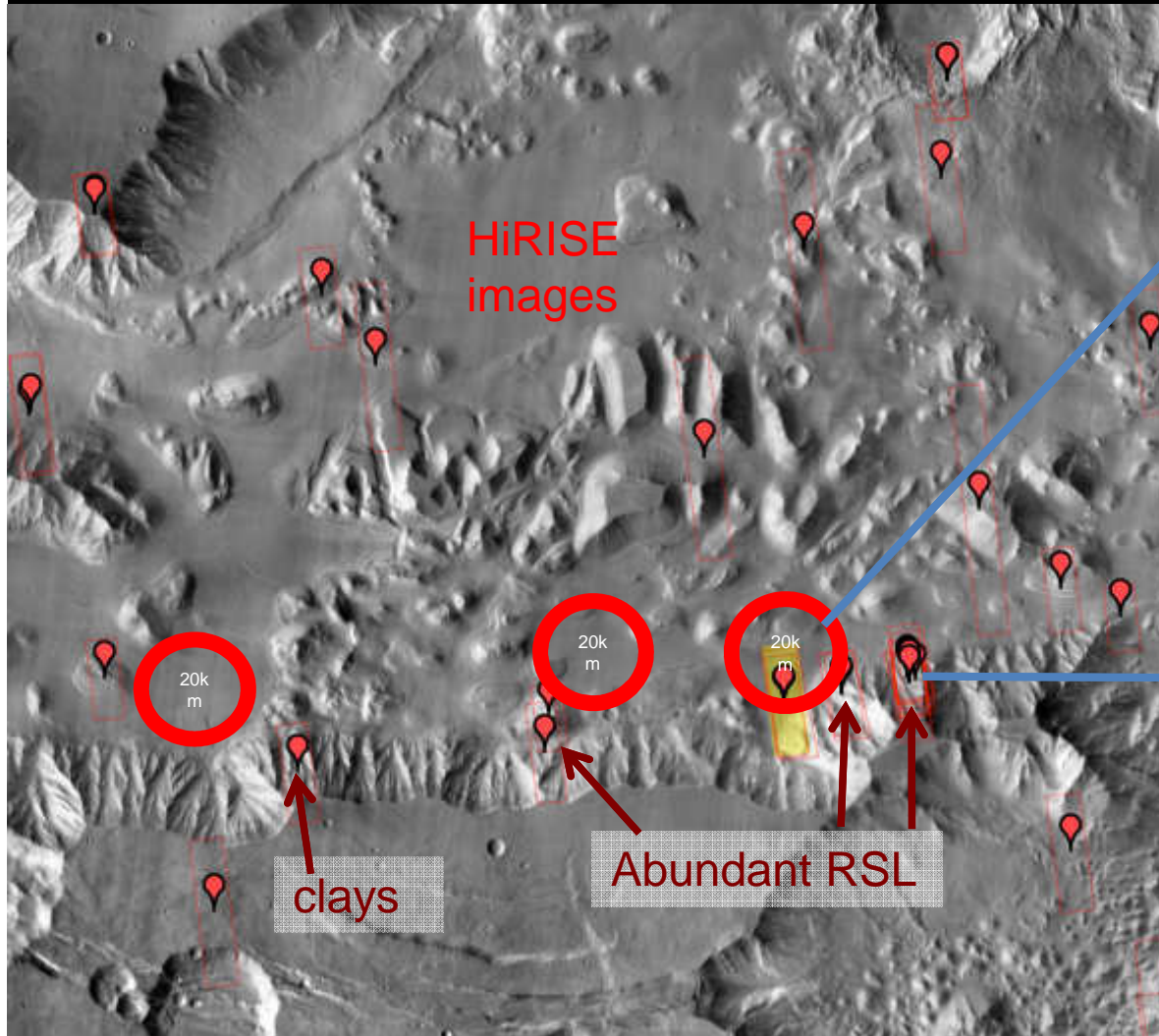
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# Candidate landing sites in Capri Chasma



Landing site mostly flat  
with 1-meter scale ripples  
ESP\_036069\_1645

nature  
geoscience

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www.nature.com/naturegeoscience

ARCTIC METHANE RELEASE  
Bubbles and storms

ANCIENT GRAPHITE  
Remnants of early life

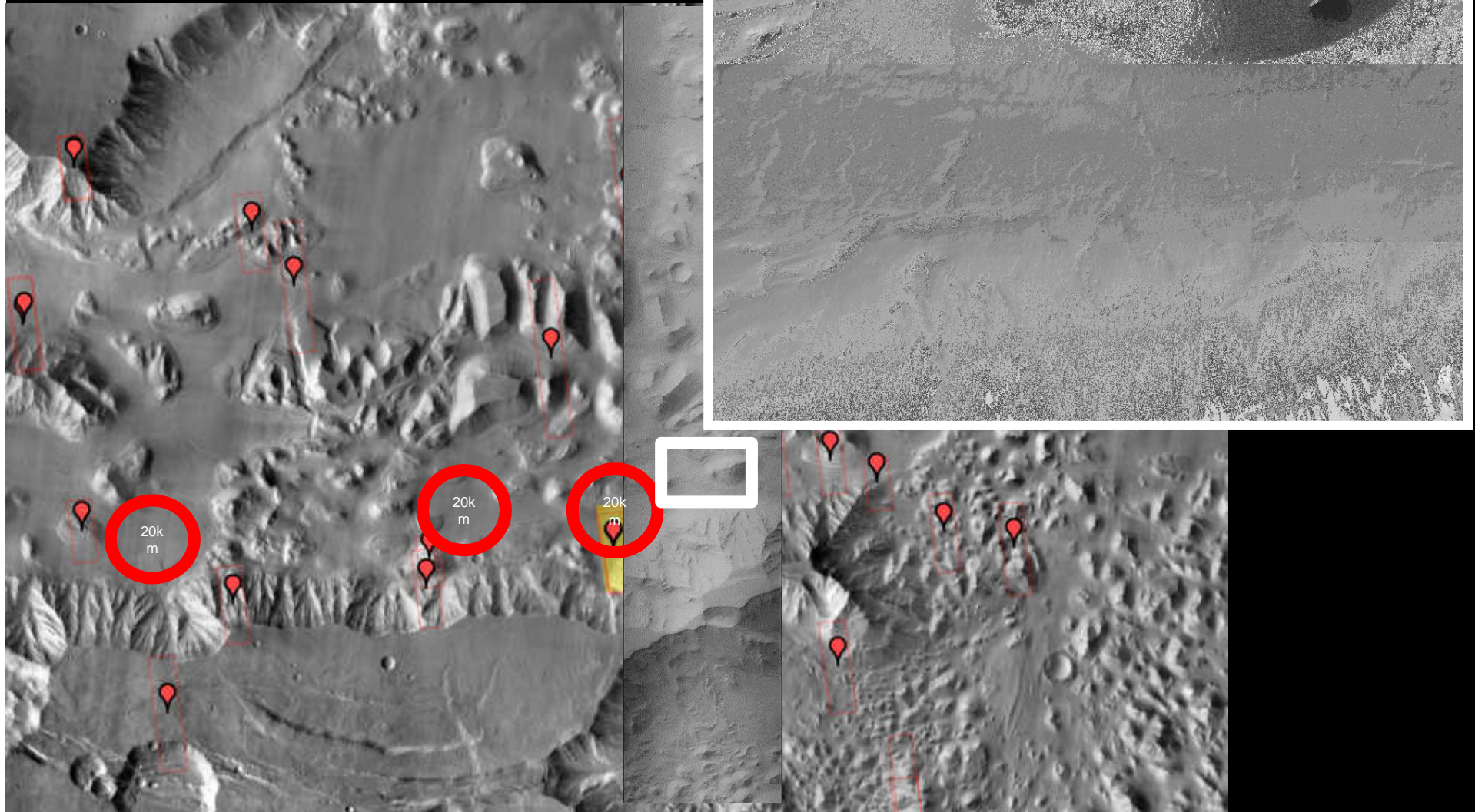
DENSE ARCHAIC CRUST  
Recycled in drips

Signs of flowing water on Mars?

More work needed to study mineralogy of this region.



# Access to volcanic rock



Floor of eastern Coprates Chasma to Capri is covered by lava (and thin sand cover)? Probably Hesperian in age, whereas most of the deep outer wall rock is Noachian.



**Site Name**

**Capri Chasma**

**Center Coordinates**

50.50W 15.23S

**Elevation**

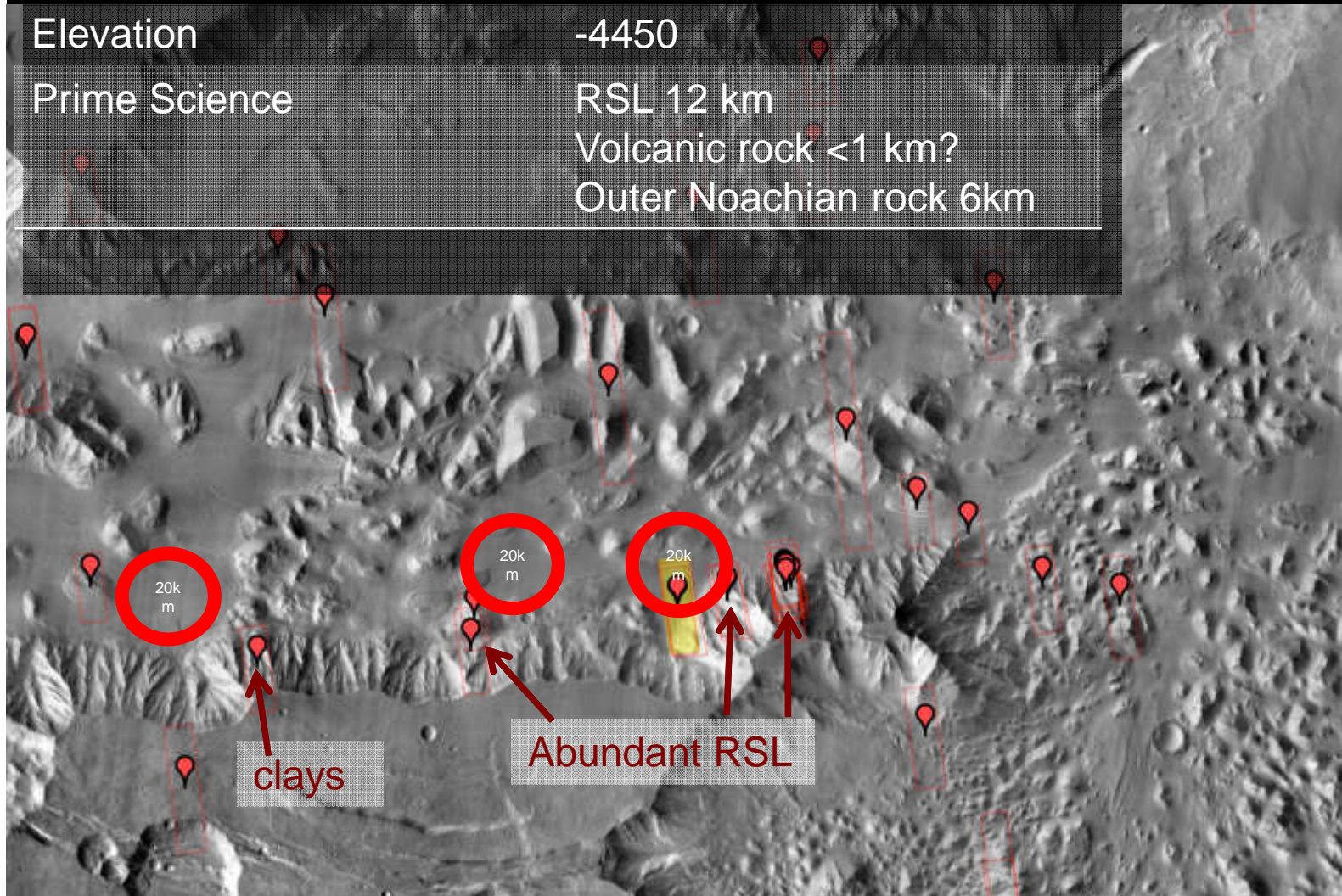
-4450

**Prime Science**

RSL 12 km

Volcanic rock <1 km?

Outer Noachian rock 6km





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